# Changing incentives for economic research in the Netherlands

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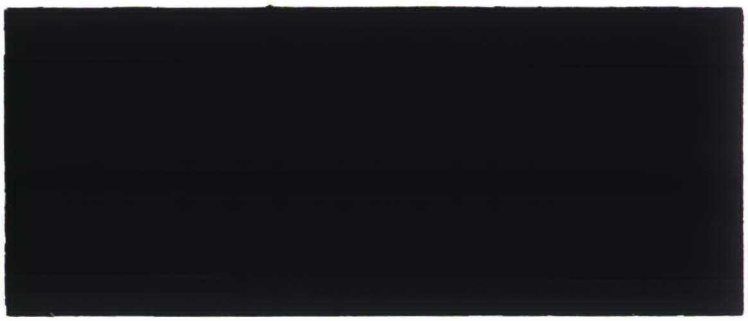

DEPARTMENT OF ECONOMICS

RESEARCH MEMORANDUM

# CHANGING INCENTIVES FOR ECONOMIC RESEARCH IN THE NETHERLANDS

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# CHANGING INCENTIVES FOR ECONOMIC RESEARCH IN THE NETHERLANDS

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## 1. Introduction

The beginning of the eighties in The Netherlands showed a university system largely engaged in recuperating from the many shocks it had experienced since the late sixties. The number of students and faculty members had grown dramatically, the formal organization had changed completely and the various groups in the new formal organization were learning to play the game of university politics.

It all started with a movement for internal and external democracy at the universities. Internally, groups of students, faculty and staff claimed a say in almost all university matters, which was up to then only reserved for the full professors. Externally, there was a movement for university education for a larger part of the population and for societal control of academic research. The movement for internal democracy led to a new formal structure in which the power was shifted from the full professors to councils in which the various groups could elect their representatives. The movement for external democracy led to a rapid growth in the number of students and to numerous discussions on the position of the universities in society. The rapid growth was of course also caused by demographic factors and by little concern about the growth of the public budget.

The new formal organization mainly had two effects. First, it led to a strong increase in bureaucracy. Second, it gave rise to a situation in which many people were more involved in the discussions in the various councils and committees than in the improvement of university education and research. These effects finally even caused a lack of interest among

many. Furthermore, the rapid growth in the number of students and the lack of concern about the size of the public budget led to a rapid growth in positions with a tenured track. As a consequence the criteria for hiring people were not very strict in that period and these people got a permanent job. The new democratic organization reinforced this change of interest within the universities.

In the beginning of the eighties the universities returned to traditional values. The new system of internal democracy survived, but the goals of the universities are clearly academic education and research again. In The Netherlands this return to traditional values was a combination of "top down" and "bottom up" policies. The government took a number of measures which all had the purpose of decreasing the costs of the universities while preserving and strengthening high quality education and research. At the same time and as a consequence of these measures highly motivated groups in the universities got more power, and they started to provide the government with ideas for the quality improvement of the universities. This strategy was very successful. For example, in the field of economics a sharp increase in research output occurred and teaching improved, while at the same time the universities suffered from large budget cuts. Very rough indicators for the teaching output per guilder and the research output per guilder show an increase by about 75 % for both between 1980 and 1987.[1] Teaching output is simply defined as the number of students taught. An increase in this indicator may of course be bought at the expense of a drop in the quality of teaching, but the evaluations of both students and external committees show no signs of deterioration in the quality of teaching.

The measures of the government can be classified either as rewards for quality improvement ("carrots") or as punishments for less good performance ("sticks"). Whether or not these measures prove to be successful highly depends on the internal structure of each university and on the

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1 The basis of these calculations can be found in HOOP (1989) and in various annual reports by universities on the number (weighted or unweighted) of publications produced annually. The calculations are very rough indeed and are only meant to suggest an order of magnitude.

personal motivation of some of the professors. This can only be analysed on a micro level for each department separately.

In this paper we first describe in more detail the "carrots" and "sticks" which the Dutch government invented to revitalize the universities while cutting costs. After that we will sketch the effects of these changes in the external environment on internal decision making within a university. This sketch is pretty much a personal report of our own experience in the Economics Faculty of Tilburg University. We sum up in the conclusion.

## 2. Policy measures

It will not be attempted to give a full explanation of the reasons for the policy changes. One might say, however, that most of the policy measures were a conscious attempt to improve the incentive structure for academic teaching and research at the universities, or to save high quality teaching and research while bringing down total costs. Furthermore, the changes were very much the result of explicit decisions by the top policy makers at the Ministry of Education and Sciences and were certainly not asked for by the universities. On the contrary, most policy measures were met with fierce criticism from the side of the universities.

a. A new system of university education ("stick")

Until 1982, each student entering a university was working for an "old style doctorandus" degree. Formally, this could be accomplished in five years, but in practice it took about seven years on average to get this degree. The drop out rate was very high, largely because a substantial number of students never was able to pass the first year's exam. This is due to the Dutch tradition that everybody can try (there is no entrance exam), but after one year a serious selection takes place. More importantly, however, the long stay of the students in the system and the rapid growth of the number of students entering the system had made it very expensive. Moreover, it was felt that the lengthy curriculum did not fit in with the careers of most students. The curriculum often was tailored to the few students who would go on to write a doctoral thesis, rather than

to the vast majority who would go on to work for private firms or the government.

As of September 1982, university education in The Netherlands is organized in a so-called two-tier system. The first tier of the system lasts four years and leads to a "new style doctorandus" degree, which is comparable with a masters degree. This is the final degree for most students. Students are allowed to take up to six years to finish this four year programme. A longer stay in the system is effectively ruled out. The second tier of the system is a four year doctoral programme for only a small number of students. The doctoral students are university employees who are expected to complete a doctoral programme and to provide some teaching or research assistance in return for a modest salary.

b. Cooperation in doctoral programmes ("carrot")

The new system of university education was launched in september 1982, so that the second tier of the system started for the first time in 1986. The Ministry set aside some money to give start-up grants to initiatives for cooperation in joint doctoral programmes. The form of these programmes was left to the profession. In economics, two different initiatives received a five year subsidy from the government. The Erasmus University (Rotterdam), the University of Amsterdam and the Free University (Amsterdam) established the "Tinbergen Institute", which is a research institute, responsible for the doctoral students in economics and business administration at those three universities. A very different set-up is provided by the "Network Quantitative Economics", which is an association of mainly economic theorists and econometricians of all Dutch universities, offering a formal curriculum and supervision. In contrast to the Tinbergen Institute, the Network covers all universities, but on the other hand it only covers part of economics. Next to these organizations there exist others which did not receive a subsidy, but which nevertheless provide similar services. In particular, there exist several other networks providing doctoral courses in subdisciplines of economics. Currently there is a movement towards integration of the various organizations into one comprehensive system of national doctoral training. Clearly, there are many advantages to having nationally organized doctoral programmes. The expertise of the best people of all universities can be drawn upon for courses as well as supervision, and a wide variety of doctoral courses can

be offered in an efficient manner. The possibility to exploit these advantages is very much given by the geographical concentration of the universities in The Netherlands.

c. Conditional finance of research (CFR) ("carrot"/"stick")

Until 1982, universities were basically financed on the basis of numbers of students. Where faculty members were supposed to spend about half of their time on research, the research capacity of a university pretty much followed the number of students. This system did not create any financial incentive for the university to attract good researchers, since research output was almost irrelevant for the university budget. In 1982 the Ministry introduced an evaluation scheme for university research. A part of the budget for university research was set aside and the universities were told that they could only get this money on the condition that they had enough approved research programmes. Researchers had to formulate five-year research programmes which were evaluated by external referees. In principle, the idea was that, if a university had not enough approved research programmes to cover their existing research input, their budget was cut. In that case the budget of other universities which had more than enough approved research programmes could actually grow. This reallocation of resources on the basis of external evaluations has not fully materialized yet, partly because of heavy protests from the side of the universities. Nevertheless, the potential threat of loosing money due to the negative evaluation of research programmes stimulated the universities to take the quality control of their research much more seriously than before. In 1986, these CFR programmes constituted about 75 % of the resources for university research.

d. Budget cuts ("stick")

Both in 1982 and in 1986, when a new government took office, university budgets were cut. The size of the cuts was rather limited as compared to the total size of the budget. In 1982 Dfl. 258 million was cut and in 1986 Dfl. 130 million. The total budget for all universities combined in both years was in the order of Dfl. 3.5 billion. More importantly, however, the Ministry intended not to use the "cheeseslicer" (typical Dutch instrument) for all departments, but to close down some departments completely. In economics, for example, it was announced in 1982 that of the five departments of econometrics in The Netherlands only two would

survive. The argument for this case was the low number of students, but in other fields also a lack of quality could be the reason to close down a department. Committees were set up to evaluate the different departments and to make recommendations about the implementation of the budget cuts. Under storms of protest from the side of the universities many of these plans never materialized and one mainly resorted to the cheeseslicer again. For instance, none of the econometrics departments was shut down. However, it had become clear once and for all that a university job was no longer secure forever, and that departments that were unsuccessful in one way or another could go under.

e. Change of salary scales ("carrot"/"stick")

In the beginning of the eighties the salary composition of the faculty members was top-heavy. The majority of the faculty members had been appointed during the rapid expansion in the sixties and early seventies. Because in that period money was ample, these people were placed in high salary scales with guarantees for a steady increase in salary. Money became less ample and after 1978 faculty members were appointed in lower salary scales with a slower growth. Since selection during the big expansion had not been very strict, a sharp contrast arose between, on the one hand, a large group of middle-aged less productive faculty members with a high salary and, on the other hand, a small group of young productive faculty members with a low salary and little career prospects. Furthermore, increases in salary were only dependent on seniority and not on performance. This situation made it also very difficult for the universities to hire new personnel and to compete with private enterprises for the bright young people. The Ministry introduced a new system of university ranks with very strict rules for promotion. The new ranks were assistant professor, associate professor, full professor, where in the full professor rank two salary scales were distinguished ("A" and "B"). Every faculty member had to be placed in one of the new ranks. Because the number of full and associate professorships was limited, the total wage bill of the universities was also reduced and this released funds to create new incentives.

f. Post-doc grants ("carrot")

Since 1987, the Ministry made a small part of the money saved by the budget cuts available again for university research in the form of post-doc grants. Although the salary scales were changed, it remained difficult to recruit the bright young doctorates for a university career. These post-doc grants are meant to employ young researchers for three or five years. The incentive for them is that they can do full-time research at good salaries. Each year about fifty grants are awarded. On average about two or three of these are awarded to researchers in economics. Although these numbers are relatively modest, incentives are created for the departments to find people who can be nominated. Departments do not only get these researchers for free, but having a number of these luxurious post-doc grants in a department is also a sign of quality which can be used in other applications for extra research money, or to get around new budget cuts.

g. External evaluation of teaching ("stick")

Since 1988, the Ministry sees to the evaluation of the university curricula by national committees of independent experts (for example, Dutch scholars who are working abroad serve on these committees). The evaluation takes place once every five years and involves extensive fact finding. The result of the evaluation is published, so that this judgement on the performance in education of each department may influence its reputation and, hence, the inflow of students. Since the university budget is strongly related to the number of students, it can be expected that the universities will take the quality control of teaching and the design of curricula very seriously. For economics, the first evaluation takes place in 1990.

h. External evaluation of research in economics ("stick")

In 1985, a fact finding committee, set up by the Ministry, published a report on the profile and productivity of research in economics at the Dutch universities. The general conclusion was that the research output was far too low, especially in journals with an international exposure, and that economic theory received relatively little attention. The findings varied of course over the subdisciplines. Econometrics came out as the most successful field, whereas for business administration the tentative conclusion was that little research was going on.

i. Centres of excellence ("carrot")

On top of the elaborate system of quality control and incentives the Ministry sometimes also allocates seed money for the founding of so-called "centres of excellence" in certain fields. In economics such is a center is the Center for Economic Research (CentER) at Tilburg University. It is a matching fund set-up with a university to create a stimulating environment without too many restrictions in order to breed excellent research.

## 3. How it works in practice

For most of the eighties, we were both members of the econometrics department of the Faculty of Economics at Tilburg University. The Faculty has about 125 members and approximately 4000 students of economics, business administration, econometrics and information management.

In the Spring of 1982 the Ministry announced that the department of econometrics (which includes mathematical economics, management science and operations research) of Tilburg University had to close down, because the number of students was too small. A concerted lobbying and publicity effort prevented this, partly because the decision makers could be convinced that econometrics was in many respects the most successful part of Dutch economics. Despite the happy ending, most of the members of our econometrics department came to the important conclusion that no one was save anymore from loosing a job. Raising the number of students by good teaching and improving the quality of research was identified as the main safeguard against new unpleasant surprises. It is interesting to note that presumably due to the publicity about this issue the number of students in econometrics tripled in a few years after the threatening announcement (this happened nationwide).

In 1985 the committee for the evaluation of economic research in The Netherlands published its report. It was very critical of the quality and scope of economic research in our country. Still some universities fared better than others. Especially Tilburg University came out badly. The report was taken very seriously by the university administration and by parts of the Faculty. More or less at the same time the restructuring of salary scales took place and difficult decisions had to be made as to who was worthy of the few prizes that could be awarded. The threat of

unpleasant surprises at new rounds of budget cuts and the unfavourable report by the fact finding committee were enough for the university administrators and the main decision makers within the Faculty to decide that quality should be the decisive criterion for the better positions, and not seniority. This is less obvious as it may seem, which can be concluded from the fact that certainly not all universities adopted this stance. Some of the more senior faculty members, who were effectively demoted to assistant professors as a consequence of this procedure, decided to leave. They found employment in private enterprises or in universities that had decided to weigh quality less heavily. In addition, our department of econometrics succeeded in convincing the board of the university that this was a golden opportunity to attract good young faculty members from universities where seniority was given priority. As a result of this the econometrics department hired two young promising associate professors who had missed out on the desirable positions at their own institution. All this took heavy lobbying by a few motivated individuals, but clearly they would not have stood a chance if the university policy makers had not realized the seriousness of external threats and the importance of having high quality faculty members as a safeguard.

Tilburg University rigorously adopted the national system of conditional finance of research (CFR) as a basis for the allocation of research budgets between the faculties. The department of econometrics benefited to a great extent, because it was the first within the Faculty of Economics to realize the opportunities offered by the new system and because it had quite a few good research groups. In the beginning the Faculty as a whole was relatively slow in developing enough consistent research programmes and as a result it lost a substantial part of its budget to faculties which had been quicker in understanding the principle. Currently, the Faculty is regaining ground and as a consequence the research budget of the Faculty is increasing. The competition within the university for the research funds is becoming fiercer every year. As a result of this, good researchers become more valuable every year and, hence, both their salary and their influence increase.

The new two-tier system of university education required the development of ideas on the form of the doctoral programmes. The experience in

the U.K. and the U.S.A. learned that a department could not afford to miss out on this. Because it was felt that it could eventually prove to be difficult to sustain a strong doctoral programme all by itself, some members of our department joined forces with colleagues in other departments in the country to cooperate in a joint doctoral programme in quantitative economics. The Network Quantitative Economics was established and it received a start-up grant from the Ministry. As of September 1986 the Network provides supervision and organizes a formal curriculum for doctoral students in quantitative economics of all universities in which the best researchers from inside and outside the country are teaching courses.

Many members of the Faculty of Economics were not very enthousiastic about the changes that took place. Many "certainties" of the sixties and the seventies turned out to be very uncertain indeed, and the career prospects of quite a few faculty members lost much of their brightness under the new rules of the game. Certainly in the early eighties, the rather agressive econometrics department was considered by the other departments in the Faculty as a pain in the neck. Gradually it was realized, however, that many of the changes were inevitable in the rapidly changing external environment and the tension eased a bit. In the process of change, the students have played an important role. As was indicated in the introduction, many strategic decisions are taken by the various councils in which all groups are represented. More and more the students turned out to act as impartial decision makers who could break the balance of power between the representatives of the various parties.

## 4. Conclusion

Although quite a few of the measures described were never fully implemented, because of the strong resistance on the part of the universities, the whole atmosphere definitely changed over the last decade. The Dutch universities have become better prepared to compete and cooperate with other European universities in a united Europe.

Many of the policy measures taken are of the carrot type. The extent to which these measures work appears to depend quite a bit on the presence

of motivated individuals within a university. Where the presence or absence of such individuals in any given organization is often a matter of chance, the final effect of many of the measures may vary a great deal across universities.

Another aspect of the measures taken is that almost all of them were directed at a change in the external environment in which the universities have to operate. The internal organisation of the universities has hardly been altered. However, the new external environment has made quality so much more important in the minds of university decision makers that the informal power structure has shifted substantially in the direction of the profession.

**References**

HOOP (1989), Hoger Onderwijs en Onderzoek Plan, Feiten en Cijfers, Ministry of Education, Zoetermeer.

Hazeu, C.A., (1989), Systeem en Gedrag in het Wetenschappelijk Onderzoek, VUGA, 's-Gravenhage.

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